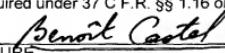


TRANSMITTAL LETTER OF THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		Attorney Docket No. <u>2002-1002</u> U.S. Appl. No. <u>10/088118</u>
INTERNATIONAL APPLN. NO <u>PCT/EP00/09101</u>	INTERNATIONAL FILING DATE <u>September 14, 2000</u>	PRIORITY DATE CLAIMED <u>September 15, 1999</u>
TITLE OF INVENTION: BELT		
APPLICANT(S) FOR DE/EO/US: <u>ARJEN BRANDSMA, JOHANNES HENDRIKUS VAN LITH, AND CORNELIS JOHANNES MARIA VAN DER MEER</u>		
Applicant herewith submits to the United States Designated Elected Office (DO/EO/US) the following items and other information		
<ol style="list-style-type: none"> <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31) <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c)(2)) <ul style="list-style-type: none"> a. <input checked="" type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau) b. <input type="checkbox"/> has been communicated by the International Bureau. See attached PCT/IB/308. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US) 6. An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)) <ul style="list-style-type: none"> a. <input type="checkbox"/> is attached hereto. b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 7. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) <ul style="list-style-type: none"> a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made, however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)) 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10. <input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). 		
Items 11 to 20 below concern document(s) or information included:		
<ol style="list-style-type: none"> 11. <input checked="" type="checkbox"/> Information Disclosure Statement (IDS) w/PTO-1449 - <input checked="" type="checkbox"/> Copy of IDS citations 12. <input checked="" type="checkbox"/> Assignment Papers (cover sheet & document(s)) 13. <input checked="" type="checkbox"/> A FIRST Preliminary Amendment. 14. <input type="checkbox"/> A SECOND or SUBSEQUENT Preliminary Amendment. 15. <input type="checkbox"/> A substitute specification. 16. <input type="checkbox"/> A change of power of attorney and/or address letter. 17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). 19. <input type="checkbox"/> A second copy of the English language translation of the international application (35 U.S.C. 154(d)(4)) 20. <input checked="" type="checkbox"/> Other items or information: <u>Application Data Sheet, Abstract of the Disclosure, International Search Report, PCT/IPEA/409</u> 		

U.S. APPLICATION NO.	107088118	INTERNATIONAL APPLN. NO.	ATTORNEY DOCKET NO		
		PCT/EP00/09101		2002-1002	
21. <input checked="" type="checkbox"/> The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1)-(5):					
Neither international preliminary examination fee nor international search fee paid to USPTO and international Search Report not prepared by the EPO or JPO				\$1040.00	
International preliminary examination fee not paid to USPTO but International Search Report prepared by the EPO or JPO				\$890.00	
International preliminary examination fee not paid to USPTO but International search fee paid to USPTO				\$740.00	
International preliminary examination fee paid to USPTO but all claims did not satisfy provision of PCT Article 33 (1)-(4).....				\$710.00	
International preliminary examination fee paid to USPTO and all claims satisfied provision of PCT Article 33 (1)-(4)				\$100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT				\$ 890.00	
Surcharge of \$130.00 for furnishing the oath or declaration than <input type="checkbox"/> 20- <input type="checkbox"/> 30 Months from the earliest claimed priority date (37 CFR 1.492(e))				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	14 - 20 =	0	X \$18.00	\$ 0.00	
Independent Claims	1 - 3 =	0	X \$84.00	\$ 0.00	
MULTIPLE DEPEND CLAIM(S) (if applicable)				+\$280.00	
TOTAL OF ABOVE CALCULATION -				\$ 890.00	
<input type="checkbox"/> Applicant claims small entity status See 37 CFR 1.27 The fees indicated above are reduced by ½.				+	
				SUBTOTAL =	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 890.00	
TOTAL NATIONAL FEE =				\$ 890.00	
Fee for recording the enclosed assigned (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) \$40.00 per property +				\$ 40.00	
TOTAL FEES ENCLOSED -				\$ 930.00	
				Amount to be refunded:	\$
				Charged	\$
<input checked="" type="checkbox"/> A Check in the amount of <u>\$930.00</u> to cover all fees is attached. <input type="checkbox"/> The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to Deposit account No. 25-0120 in the name of Young & Thompson, as described below A duplicate copy of this sheet is enclosed. <input checked="" type="checkbox"/> The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 25-0120 for any additional fee required under 37 C.F.R. §§ 1.16 or 1.17.					
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 00466 <small>PATENT TRADEMARK OFFICE</small>					
BC/ma Date: <u>March 15, 2002</u>					
SIGNATURE 					
Benoit Castel NAME					
35.041 REGISTRATION NO.					

PATENT
2002-1002
#3/6

IN THE U.S. PATENT AND TRADEMARK OFFICE

In re application of: Arjen BRANDSMA et al.

Appl. No.:

NEW

Group:

Filed:

March 15, 2002

Examiner:

For:

BELT

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

March 15, 2002

Sir:

The following preliminary amendments and remarks are respectfully submitted in connection with the above-identified application.

IN THE CLAIMS:

Please cancel claims 1-14 without prejudice or disclaimer of the subject matter contained therein.

Please add the following claims:

--15. (New) Belt (1) for use in a continuously variable transmission, in particular for automotive application, comprising at least one set (7) of nested metal rings (2), the set (7) interacting with transverse elements (3, 6) provided slidably

along the set (7), and the rings (2) of the set (7) being accommodated with small mutual play between each pair of adjacent rings (2), characterised in, that for at least the majority of said pairs of adjacent rings (2) the nominal value of said play is zero, whereby said nominal value of zero is realised by positive and negative amounts of play between said pairs of adjacent rings (2).--

--16. (New) Belt (1) according to claim 15, characterised in, that the nominal value of zero is realised by a tolerance of 0.00005 times the outer diameter of the inner ring (2) of a relevant pair of rings (2), plus or minus of said diameter.--

--17. (New) Belt (1) according to claim 1, characterised in, that said mutual play between the innermost pair of adjacent rings (2) is of negative value.--

--18. (New) Belt (1) according to claim 17, characterised in, that the outer diameter of the innermost ring (2) is of a value (1-Z) times the inner diameter of the adjacent ring, Z being of a value smaller than 0.0008.--

--19. (New) Belt (1) according to claim 18, characterised in, that Z is of a value greater than 0.0001.--

--20. (New) Belt (1) according to claim 15, characterised in, that the mutual play of the outermost pair of adjacent rings (2) is of positive value.--

--21. (New) Belt (1) according to claim 20, characterised in, that the inner diameter of the outermost ring (2) is of a value $(1+Y)$ times the outer diameter of the adjacent ring, Y being of a value smaller than 0.0004.--

--22. (New) Belt (1) according to claim 21, characterised in, that Y is of a value greater than 0.00005.--

--23. (New) Belt (1), in particular according to claim 15, for use in a continuously variable transmission, in particular for automotive application, comprising at least one set (7) of nested metal rings (2), the set (7) interacting with transverse elements (3, 6) provided slidably along the set (7), and the rings (2) of the set (7) being accommodated with small mutual play between each pair of adjacent rings (2), characterised in, that said mutual play of the outermost pair of adjacent rings (2) is of positive value.--

--24. (New) Belt (1), in particular according to claim 15, for use in a continuously variable transmission, in particular for automotive application, comprising at least one set (7) of nested

metal rings (2), the set (7) interacting with transverse elements (3, 6) provided slidably along the set (7), and the rings (2) of the set (7) being accommodated with small mutual play between each pair of adjacent rings (2), characterised in, that the thickness of one or both of the innermost and the outermost ring (2) of the set (7) is significantly less than the nominal thickness of in-between rings (2) of the set (7).--

--25. (New) Belt (1) according to claim 24, characterised in, that the thickness of said innermost or said outermost ring (2) is at least lower than twenty percent (20%) of the average value of the thickness of the in-between rings (2).--

--26. (New) Belt (1), in particular according to claim 15, for use in a continuously variable transmission, in particular for automotive application, comprising at least one set (7) of nested metal rings (2), the set (7) interacting with transverse elements (3, 6) provided slidably along the set (7), and the rings (2) of the set (7) being accommodated with small mutual play between each pair of adjacent rings (2), characterised in, that the material composition of at least one of the innermost and the outermost ring (2) of the set (7) significantly differs from that of the in-between rings (2) of the set (7), such that the elasticity modulus thereof is significantly lower than that of in-between positioned rings (2).--

--27. (New) Belt (1) according to claim 26, characterised in, that the elasticity modulus of said innermost and said outermost ring (2) is at least twenty percent (20%) less than the average value of the elasticity moduluses of the in-between rings (2).--

--28. (New) Continuously variable transmission provided with a belt (1) according to claim 15.--

REMARKS

Claims 15-28 are pending in the present application.

Claims 1-14 have been cancelled and claims 15-28 have been added.

Entry of the above amendments is earnestly solicited.

An early and favorable first action on the merits is earnestly requested.

Should there be any matters that need to be resolved in the present application, the Examiner is respectfully requested to contact the undersigned at the telephone number listed below.

The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

YOUNG & THOMPSON



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BC/ma
Attachments

2/p6/s

BELT

5

The present invention relates to a belt for use in a Continuously Variable Transmission as defined by the preamble of claim 1.

Such a belt is generally known, more in particular from the US patent No. 3720113. Belts satisfying the described characteristics mentioned in this document are

10 known in practice, and prove to perform satisfactorily. The set of rings shown by such belts will be described as adjacent rings, alternatively denoted hoops or strips, and adjacent meaning directly adjacent, in other words such that mutual abutment may take place between adjacent rings in a set.

Despite the known belt is at present commercially available for more than a 15 decade, and is technically known for even many more years, it is in practice still found that the endurance time of belts may still be significantly improved. It is therefor an object of the invention to enhance durability of the known belt while maintaining and preferably improving the power transmitting capacity of the known belt. According to the present invention this may in a surprisingly simple manner be achieved by applying 20 the feature of the characterising portion of claim 1.

A problem underlying the invention is how to determine one or more specific features of a belt related to the endurance thereof. One such feature is suggested by US patent No. 4579549, teaching that the innermost ring, alternatively denoted hoop, is subjected to the biggest tensile stress of all the hoops. Decrease of tensile stresses 25 of the innermost hoop is mentioned to enhance the service life thereof and therewith of the belt. For achieving such, the document further indicates the hoops of a set to be "superimposed with no clearance between abutting hoops". This indication is in the document explained to mean that each of the hoops has an outer circumferential diameter adapted to be equal to, or larger than, an inner circumferential diameter of an 30 abutting outer hoop. The technical effect of such measure is suggested to be that the tensile stresses of the hoops increase with the increase in diameter thereof. This measure is further explained to be found as an inverse or opposite effect found at prior art belts "which have clearances of 30 µm between abutting hoops", and which prior art belts featured a decreasing tensile stress with an increasing diameter of the 35 respective rings. It is here remarked that said latter prior art feature fits the teaching of

above mentioned earlier publication US-3720113 in that practically no play could include a play of 30 μm for as far as belts of a dimension within the range for regular automotive application are concerned.

5 A confirmation of the teaching of above mentioned publication US-4579549 is provided by the recent publication of Japanese patent abstract No. 10169719 of application No. 08332187. In this publication the rings of a set are indicated to require a likewise so called minus clearance or, alternatively denoted, a negative play.

Both said abstract and said US patent No. 4579549 suggest the characteristic of play between rings of a set to be important in relation to life time of a belt. These 10 documents however provide a measure effecting a confusingly inverse effect on distribution of belt tension in the rings of a set.

As to US patent No. 3720113, when interpreted with the teaching of said US patent No. 4579549, pointing to play between rings, it is found that rings of the first known belt "are super imposed with practically no play." For a practical implementation 15 and for use as a starting point for improvement, this indication is too vague. An obvious interpretation of this teaching however, would be to utilise the inverse expression, indicating that the rings are superimposed with some play, be it practically absent. Belts of this nature are likely to show the distribution of tensile stresses conforming to the distribution shown as prior art in US-4579549, i.e. will have highest 20 tensile stress at the innermost ring. Adopting the solution of the latter US-4579549 document, it is unsatisfactory found that this solution leads to still one weakest ring, however, now located at the outermost side of a ring set.

The present invention overcomes the drawbacks of all prior art by prescribing a play of nominal value zero. In this way an even distribution of ring stress over at least 25 the majority of the rings of a set is effected, realising a balanced transfer of tensile stress between each relevant ring. Moreover, the level of tensile stress so realised in any ring of a set is significantly lower than that in the ring with highest tensile stress in any of both known solutions. It will be found that with a belt according to the invention the life time of a belt is increased to such extend that durability may with impunity be exchanged against the level of torque to be transmitted, e.g. the effect may be utilised 30 by applying the essentially same belt in environments with higher torque to be transmitted. Should all pairs of rings be accommodated with play of nominal value zero, it will be found that life time is enhanced in respect of belts with any above mentioned prior art measure, not in the last instance because belts are in practice found to fail 35 either through failure of the innermost ring or through failure of the outermost ring.

In order to reproduce the above effect in a sufficiently consistent and reliable manner a favoured embodiment according to the invention requires that the nominal value of zero is realised by a tolerance of 0.00005 times the outer diameter of the inner ring of a relevant pair of rings, plus or minus of said diameter. The technical effect of this measure according to the invention is that the differences of lifetime effect will remain within an accepted bandwidth for technically equivalent belts. In further detail of this effect, it will be found that that no significant difference in life time can be remarked as a consequence of this measure, since the effect hereof is that the spread of life time consequence of this measure will normally remain within the natural life 5 time spread caused by metal fatigue.

Yet another preferred embodiment of the invention requires the mutual play between the innermost pair of adjacent rings is of negative value. It is acknowledged by the invention that the innermost ring of a set, as described by US-4579549, "is subjected to both tensile forces and frictional forces". However, as indicated by the 10 measure according to claim 1, the measure subsequently taught by said publication is rejected. Rather, the favoured embodiment applies the idea underlying the present invention to solve the problem of the first ring, i.e. to take account of the tension each ring is individually subjected to. Combining this idea with the insight underlying the invention that the innermost ring is subjected to certain forces specific thereto, it was 15 found according to this specific aspect of the invention that the tensile stress should be kept relatively low in order to keep the total level of stress in the innermost ring at a level conforming to the level in remainder of the rings of a set. In this respect it was recognised that the frictional force following from interaction between the innermost ring and the transverse elements as mentioned in US-4579549, when compared to 20 frictional force resulting from ring-ring interactions is high, so that an additional frictional force should be calculated with for the innermost ring. At the innermost ring it should further be calculated with so-called Herze tensions resulting from element-ring contact. A favoured manner of keeping the level of tension in the innermost ring at the 25 level of the in-between rings of a set is, according to the invention, to reduce the tensile stress by providing some negative play for the innermost ring only.

In a further advancement of above said measure directed to the play of the innermost ring specifically, the invention is further characterised in that the outermost diameter of the innermost ring is of a value $(1-Z)$ times the inner diameter of the adjacent ring, Z being of a value smaller than 0.0008. A technical effect of the so 30 specifically identified range is that the reliability and consistency of the effect of the

measure related to the innermost belt is increased, while taking into account further sources of tension specific to the innermost belt, including e.g. so called Herz tensions originating from the element-ring contacts. In this respect the value of greater than 0,0001 effects yet a further enhancement. It will be found that, although the 5 parameter Z to some extend varies with the application of a relevant belt, a belt is stressed in conformance with the in-between ring, thus having a conforming life time, when the parameter Z is kept in the above said range.

A further specific aspect of the invention relates to a belt wherein the mutual play of the outermost pair of adjacent rings is of positive value. The technical effect hereof 10 is that compensation is provided for tension sources other than tensile stress, specific to the outer rings, such that the total tension in the outer ring may be brought into conformance with, i.e. will not be higher than, the tension in the further rings of a set. An insight underlying this aspect of the invention is that a tension source specific to the outer rings is caused by subjection to intense contact with transverse elements, i.e. 15 with the boundary opposite to the so-called saddle part, at the instant where the belt should escape out of the pulley in which it is to be operated. Since the elements are clamped between the sheaves of a pulley, they tend to rotate therewith. For transmitting force to the other pulley however, the belt and the elements should cross to the other pulley. Thus the elements are pulled out of the sheaves at the instance of 20 leaving the pulley, thereby causing intense contact between the so-called ear part of a transverse element and the outermost ring. In a further development of this aspect the inner diameter of the outermost ring is of a value $(1 + Y)$ times the outermost diameter of the adjacent ring, Y being of a value smaller than 0,0004 and preferably greater than 0,00005. When the values of this specific range are followed the technical 25 effect indicated at the range for the innermost ring will be further enhanced.

A particular aspect of the invention is characterised in that the thickness of one or both of the innermost and the outermost ring of the set is significantly by less than the nominal thickness of in between rings of the set. The invention therefor also relates to a belt for use in a continuously variable transmission, in particular for automotive 30 application, comprising at least one set of nested metal rings, the set interacting with transverse elements provided slidably along the set, and the rings of the set being accommodated with small mutual play between each pair of adjacent rings, whereby the thickness of one or both of the innermost and the outermost ring of the set is significantly less than the nominal thickness of in between rings of the set. With such a 35 measure the invention provides an alternative means of realising an evenly distributed

tension level over the rings of a set. The insight utilised in this invention is that a smaller thickness realises a lower bending stress in the relevant ring thereby lowering the tension level in said innermost and/or outermost ring, allowing the relevant ring to receive tension from sources specific therefor, without penalty in regard of life time.

5 Yet another particular aspect of the invention relates to the measure wherein the material composition of at least one of the innermost and the outermost ring of the set significantly differs from that of the in between rings of the set, such that the elasticity modulus thereof is significantly lower than that of in between positioned rings. The invention therefor also relates to a belt, in particular according to any of the
10 preceding claims, for use in a continuously variable transmission, in particular for automotive application, comprising at least one set of nested metal rings, the set interacting with transverse elements provided slidably along the set, and the rings of the set being accommodated with small mutual play between each pair of adjacent rings, whereby the elasticity modulus of one or both of the innermost and the
15 outermost ring of the set is significantly less than the nominal thickness of in between rings of the set. With such a measure yet another alternative for realising an evenly distributed tension over all rings of a set is realised. The technical effect is comparable to the preceding alternative.

In a further elaboration of the latter aspects the value for thickness and
20 elasticity modulus of said innermost and said outermost ring is at least twenty percent (20%) less than the average value of said parameters at the in-between rings. When the values of this specific ranges are followed, the technical effect in durability and torque to be transmitted, indicated a.o. at the range for the innermost ring, will be further enhanced.

25 The invention will now further be explained by way of examples given in the accompanying drawing wherein:

Figure 1 is a schematic illustration of the belt the present invention relates to, together with the transmission wherein it is to be operated;

30 Figures 2 and 3 by way of cross sections indicate transverse elements for two of many possible types of belt that may be provided with the features of the invention;

Figure 4 is a side elevation of the cross elements according to figures 2 and 3;

Figure 5 is a plot indicating the level of tension for each ring in a set of rings of a belt, both for a belt according to prior art and for a belt according to the invention,

35 and

Figure 1 shows schematically a continuous variable transmission (CVT) suitable amongst others for automotive application, with a conveyor belt 1, made up of a carrier in the form of a nested set of endless thin bands 2, otherwise denoted rings 2 5 and a multitude of separate transverse elements 3, otherwise denoted blocks 3. The elements 3 are arranged freely slidably along said carrier 7 in an endless, virtually continuous series. The carrier 7, alternatively denoted support and ring set is composed of a number of the in endless bands, alternatively denoted loops or rings. For operational application the belt 3 runs within the V-shaped groove of the pulleys 1 10 and 2 with steplessly variable diameter. Its elements 6 are provided with inclined contact faces for contacting the sheaves 4 and 5 of said pulleys. The pulleys 1 and 2 are provided on shafts P and S respectively. When pinched sufficiently strong between the sheaves of a pulley 1, 2 the belt 3 transmits force from one rotating pulley to the other. The elements 6, as seen in cross section preferably have a lower part of which 15 at least one principle side is inclined relative to the upper part at the same side, so that the element 6 becomes thinner towards the side directed to the inner side of the belt. Such a continuous variable transmission is known per se. The elements 6 further are provided with generally slightly convexly shaped contact faces also denoted saddles for contacting the support 7, in particular the innermost band thereof.

20 In operation the belt, through the rotation of a driving pulley passes a trajectory with upper and lower predominantly straight parts between the pulleys, and with first and second predominantly circular trajectories, where the belt is clamped by the sheaves of a pulley. In one of the straight parts each time, between the pulley clamped circular trajectories of the belt, the carrier 7 may be subjected to highest tensile forces.

25 In practice the belt in one straight part may become somewhat buckled due to the elements pushing against each other, thereby virtually forming a metal rod between said pulleys, and having the tendency of splashing apart. This tendency however, is counteracted by the carrier 7, which according to the invention in the push is may be subjected to relatively high tensile stresses. However, high tensile stress may 30 depending on the state of the belt, also occur at the opposite straight part where the belt, i.e. the carrier 7, is subjected to high pulling force.

Figure 2 and 3 show possible embodiments of a transverse element 6. Figure 2 depicts a so called single package element having a central opening 13 for receiving a ring package, alternatively denoted set of rings 7. The opening is bounded to its upper 35 side by a removable closure element 10, e.g. embodied by a pin. The pin 10 is

received by opening 11 and 13 respectively, provided in upwardly parts of the element defining the opening 13. In a lower part thereof, each element is provided with side faces 8 for contacting the side faces the respective sheaves of a pulley in a matching plane.

5 Figure 3 depicts an embodiment for receiving dual ring sets 7, for which purpose two ring receiving slots 14 are provided. Each slot 14 are provided. Each slot 14 has a lower saddle part and an upper boundary provided through an upper T-shaped element part.

Figure 4 shows the contact face 8 to be roughened in the depicted example, embodied by rills 16 and grooves 15, so as to allow passage of a cooling medium such as transmission oil. Figure 4 further shows the elements 6 to be relatively thin, and to have a lower element part declining in thickness towards its lower end so as to allow a belt to be bent when passing a pulley trajectory. Due to a tension within a set of rings the innermost ring at least the part thereof pressing a trajectory within a pulley is in stiff contact with the so called saddle part of an element, i.e. the lower element part of the spaces 13 and 14 for ring sets in the figures 2 and 3 respectively.

Figure 5 is a figurative representation of the highest possible tension S occurring in any above mentioned parts or trajectories passed during operation of the belt, plotted for each ring N of a ring set, here provided with 10 rings. Number 1 in the plot stands for the innermost ring of the set, whereas No. 10 stands for the outermost ring. A similar plot can be made up for any number of rings in a set. The broken line in figure 4 represents a commercially available belt provided with practically no play, i.e. with at least some play between the rings. The solid line represents the tension in each ring of a belt according to the present invention in which the play between the ring has, as expressed in technical terms, a nominal value of zero. In common language this means that an inner ring of any pair of rings of a set may have some play relative to the outer ring, or may be somewhat longer than the inner diameter of the outer ring. In technical terms these states are denoted positive and negative play respectively. The notion nominal further includes that the average value of plays of a given number of pairs of rings is zero. In technical sense this zero value includes a certain margin. In the construction a favourable embodiment of the margin would be 0.00005 times the outer diameter of an inner ring of any pair of a set in each direction, i.e. plus or minus of said outer diameter.

CLAIMS

1. Belt for use in a continuously variable transmission, in particular for automotive application, comprising at least one set of nested metal rings, the set interacting with transverse elements provided slidably along the set, and the rings of the set being accommodated with small mutual play between each pair of adjacent rings, characterised in, that for at least the majority of said pairs of adjacent rings the nominal value of said play is zero.
- 5 2. Belt according to claim 1, characterised in, that the nominal value of zero is realised by a tolerance of 0.00005 times the outer diameter of the inner ring of a relevant pair of rings, plus or minus of said diameter.
- 10 3. Belt according to claim 1 or 2, characterised in, that said mutual play between the innermost pair of adjacent rings is of negative value.
- 15 4. Belt according to claim 3, characterised in, that the outer diameter of the innermost ring is of a value (1-Z) times the inner diameter of the adjacent ring, Z being of a value smaller than 0.0008.
- 5 5. Belt according to claim 4, characterised in, that Z is of a value greater than 0.0001.
- 20 6. Belt according to any of the preceding claims, characterised in, that the mutual play of the outermost pair of adjacent rings is of positive value.
7. Belt according to claim 6, characterised in, that the inner diameter of the outermost ring is of a value (1+Y) times the outer diameter of the adjacent ring, Y being of a value smaller than 0.0004.
- 25 8. Belt according to claim 7, characterised in, that Y is of a value greater than 0.00005.
9. Belt, in particular according to any of the preceding claims, for use in a continuously variable transmission, in particular for automotive application, comprising at least one set of nested metal rings, the set interacting with transverse elements provided slidably along the set, and the rings of the set being accommodated with small mutual play between each pair of adjacent rings, characterised in, that said mutual play of the outermost pair of adjacent rings is of positive value.
- 30 10. Belt, in particular according to any of the preceding claims, for use in a continuously variable transmission, in particular for automotive application, comprising at least one set of nested metal rings, the set interacting with transverse elements provided slidably along the set, and the rings of the set being accommodated with

small mutual play between each pair of adjacent rings, characterised in, that the thickness of one or both of the innermost and the outermost ring of the set is significantly less than the nominal thickness of in-between rings of the set.

11. Belt according to claim 10, characterised in, that the thickness of said innermost or said outermost ring is at least lower than twenty percent (20%) of the average value of the thickness of the in-between rings.
12. Belt, in particular according to any of the preceding claims, for use in a continuously variable transmission, in particular for automotive application, comprising at least one set of nested metal rings, the set interacting with transverse elements
- 10 provided slidably along the set, and the rings of the set being accommodated with small mutual play between each pair of adjacent rings, characterised in, that the material composition of at least one of the innermost and the outermost ring of the set significantly differs from that of the in-between rings of the set, such that the elasticity modulus thereof is significantly lower than that of in-between positioned rings.
- 15 13. Belt according to claim 12, characterised in, that the elasticity modulus of said innermost and said outermost ring is at least twenty percent (20%) less than the average value of the elasticity modulus of the in-between rings.
14. Continuously variable transmission provided with a belt according to any of the preceding claims.

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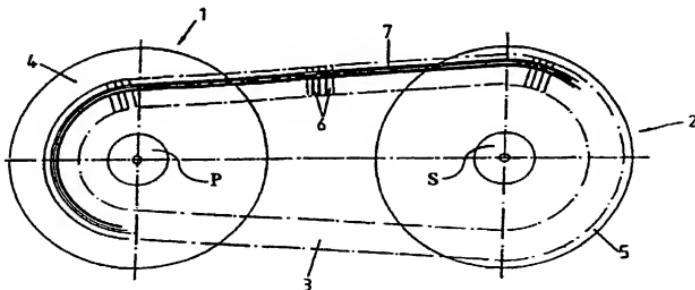
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **BELT**



(57) Abstract: The present invention relates to a belt for use in a continuously variable transmission, in particular for automotive application, comprising at least one set (7) of nested metal rings, the set interacting with transverse elements (3) provided slidably along the set, and the rings of the set being accommodated with small mutual play between each pair of adjacent rings, characterised in, that for at least the majority of said pairs of adjacent rings the nominal value of said play is zero.

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FIG.1

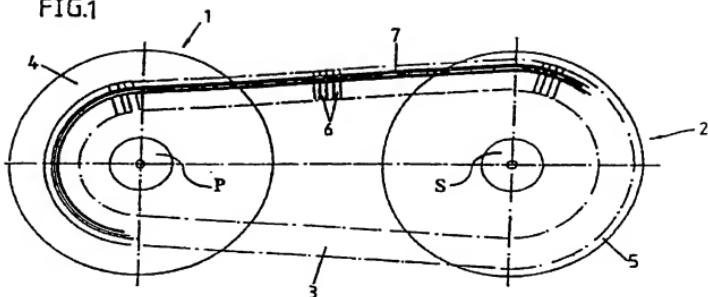


FIG.2

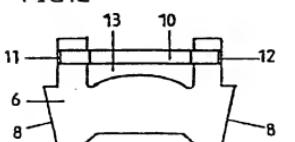
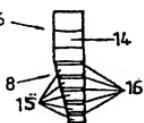


FIG.3



FIG.4



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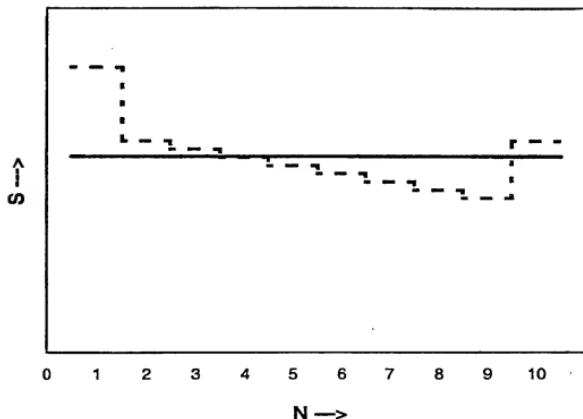


FIG. 5

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As a below named Inventor, I hereby declare that

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: BELT

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REGULAR OR DESIGN APPLICATION

is attached hereto.

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and was amended on _____ (if applicable).

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was described and claimed in International application No. PCT/ER00/09101 filed on September 14, 2000 and as amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

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I hereby claim foreign priority benefits under 35 USC 119 of any foreign application(s) for patent or Inventor's certificate listed below and have also identified below any foreign application for patent or Inventor's certificate having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(S)

Country	Application Number	Date of Filing (day, month, year)	Priority Claimed
EUROPE	98203013.0	15 September 1999	Yes

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional patent application(s) listed below:

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Docket No. 2002-1002

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The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from **VAN DOORNE'S TRANSMISIE BV**, as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

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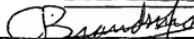
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1-00

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